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ABSTRACT

The historical background of mastery learning is discussed and related to the use of the traditional normal curve and to the nature of curves which express more adequately the mastery learning concept. It is suggested that the mastery model calls for strategies that: inform students about course expectations; set standards of mastery in advance; use short diagnostic tests for each unit of instruction; prescribe additional learning for those who do not demonstrate initial mastery; and provide additional learning time for those who need it. These strategies for mastery learning and testing can benefit the student who experiences test anxiety. Suggestions for the construction of mastery tests include defining the objectives to be measured, items written to sample the content and behavior domains of those objectives, average item difficulty ranging from 85% or higher, and absolute performance interpretation. Proposals for the application by teachers of the principles suggested, techniques for test construction, test use, and grading, are presented. (CK)

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measurement in education

A SERIES OF SPECIAL REPORTS OF THE NATIONAL COUNCIL ON MEASUREMENT IN EDUCATION

Mastery Learning and Mastery Testing

Samuel T. Mayo

ABOUT THIS REPORT

Student activism and the civil rights movement have had a number of objectives in common. Among these are an urgent interest in improving the educational process and making instruction more relevant to the individual needs of young people. Consequently, in recent years great stress has been placed upon organizing educational objectives and methods so that *all* students learn and also that educational outcomes are useful and meaningful to each individual.

While this current of social values has gained momentum, there has been a gradual but marked reorientation in scientific thinking about the most effective ways to help people learn. Whereas reward and punishment were once paramount in theories of learning, ideas of organization and structure now dominate major innovations such as programmed instruction and computer assisted instruction.

Mastery learning can be characterized as a method of organizing discrete educational objectives which are meaningful and useful to the individual. In that sense it is one important offspring of these recent social and scientific developments. This report indicates the importance of mastery testing of mastery learning. Professor Mayo has long been an officer of NCME and is well equipped to handle the topic. Not only is he review editor of *Psychometrika* but he has also been a chairman and consistent contributor to testing issues of *Review of Educational Research.*

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SAMUEL T. MAYO

Mastery learning is not a new idea but it has not always gone under that name. The word "mastery" is very common in educational parlance. It connotes having learned something well as promised in the adage, "Practice makes perfect." Mastery usually comes easily when there is a very limited skill or parcel of knowledge to be learned and one has the opportunity for abundant practice. Moreover, with mastery comes a feeling of pleasure and self-confidence from a job well done.

In the study of human learning, educational psychologists long ago discovered two important principles: (1) Given meaningfulness, learning is retained easily when there is abundant practice; and (2) Meaningful learning is easily transferred. "Meaningful" here means bearing a relationship to previous learning. It also implies that the goals to be obtained are obvious. Transfer, in essence, means that one is able to use previous learning by applying it to solution of problems or decision making.

Until ten or fifteen years ago prevailing practices of instruction and evaluation of instruction promoted unsound effects on learners. Individual differences were often neglected in "lockstep instruction." In a sense, instructional time was held constant while the amount of material learned varied. The normal curve was being overused and misused in evaluation processes. Mastery learning differs in that, in a sense, material is held constant, while study time is allowed to vary.

The picture has been changing rapidly. Entire curriculums, particularly in mathematics and physics, have been revolutionized. Programmed learning has had impact on almost every school system. Independent study and individualized instruction, either with or without machines, are being tried in more and more schools every year. Such innovations in the learning environment call for innovation in testing, measuring, and evaluating techniques. Useful references for further reading would be those by Bloom (1968), Bruner (1960), and Carroll (1963).

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Until recently, most people were convinced that mental abilities were somehow tied very tightly to academic achievement. This point of view was valid under traditional instruction when one constructed achievement tests in such a way as to assure a normal distribution of the scores. It should be noted that mental abilities, as measured, have also been distributed like a normal curve.

The expectation of the distribution of achievement for traditional treatment is a normal curve, or something similar to Curve A of Figure 1, with central tendency in the midregion. By contrast, mastery treatment is expected to shift central tendency closer to perfection and probably to show skewness as well, as in Curves B and C of Figure 1.

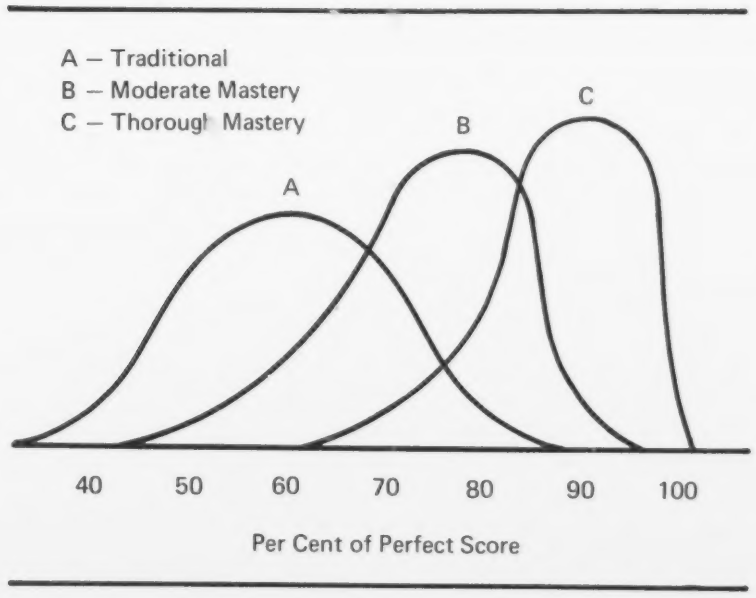

Figure 1. Distributions of Achievement Test Scores Under Traditional Treatment and Mastery Treatment (Hypothetical)

In programmed instruction questions in the frames are made so easy that the resulting error rate is only 5 to 10 percent. For such cases a different kind of proficiency test is called for – a test for mastery in which the score distribution is very different from that of the normal curve. Instead of being piled up in the middle and tapering gently in each direction, scores are bunched at the high end of the scale. The test items for the new type of proficiency test obviously must be of a different type from those which have been recommended for traditional achievement tests. Mastery test items are tied intimately to the stated objectives of instruction which are specific for a relatively short period of time in a school course (even for a day's lesson). But programmed learning is only one of several innovations in what may be called mastery learning.

THE MASTERY MODEL

The term "mastery model" is used here to summarize the thinking of some educators who have tried out certain innovations to improve school learning.

Rather than thinking of aptitude as a kind of ceiling, Carroll (1963) suggested that aptitude may be related to the amount of time necessary to achieve mastery. Bloom (1968) feels that if students are normally distributed with respect to aptitude and if the kind and quality of instruction and the amount of time available for learning are made appropriate to the characteristics and needs of each student, a large majority of the students can be expected to achieve mastery.

Briefly characterized, the model calls for such strategies as these:

1. Inform students about course expectations, even lesson expectations or unit expectations, so that they view learning as a cooperative rather than as a competitive enterprise.
2. Set standards of mastery in advance; use prevailing standards or set new ones and assign grades in terms of performance rather than relative ranking.
3. Use short diagnostic progress tests for each unit of instruction.
4. Prescribe additional learning for those who do not demonstrate initial mastery.
5. Attempt to provide additional time for learning for those persons who seem to need it.

TEST DEVELOPMENT – A MASTERY APPROACH

Test experts and authors of textbooks on tests and measurement have been telling teachers for many years to construct their achievement tests in traditional ways. What are these ways? The answer to this question may be expressed as a series of steps: (1) Define the objectives to be measured; (2) write items to sample content and behavior domains of the objectives; (3) adjust item characteristics with average item difficulty around 50%-60% and maximum discrimination against the internal criterion of the total test scores; (4) interpret performance against a norm (i.e., peer) group.

Under the mastery model, the first two steps would remain somewhat as they were. The third step would be replaced by eliminating the necessity of discriminating power; that is, average difficulty would be shifted to possibly 85% or higher.

The kind of instruction under the model also differs from traditional, and this affects the kind of testing required. In mastery it is assumed that the response that one learns (such as giving the answer to a question or making an overt muscular response) can be made confidently upon cue. Tests constructed to measure such learning may appear easy to one accustomed to very difficult tests, especially those written by persons prone to use

"trick" questions or obscure language. Mastery tests may be conceived as operating on a "go-no-go" basis. Most students are expected to pass an item. The few who fail the item show a clear deficit, and this feedback indicates need for additional remedial learning sessions and repeated testing until items are passed.

Clear Objectives

Objectives are made clear to the student under mastery learning. We have had years of experience under the alternative in which objectives have not been made clear and in which achievement was on a sink-or-swim basis. Under a mastery approach, one plan which can be used effectively is a periodic (even daily) sheet which spells out the immediate objectives. The student has the feeling of clearly understanding the goals and knowing that they may be reached easily in a short time.

"Have a student committee make up a final examination . . ."

Mastery learning and mastery testing seem to promise the elimination of some of the fear which plagues many students in testing situations, especially in quantitative courses such as those in mathematics, science, and statistics. Steps that teachers can take toward overcoming fears include (1) announcing that daily quizzes will not be counted on the final grade but rather be used for diagnosis; (Such quizzes can easily be given back for students to keep in their files) (2) announcing that major tests (such as midsemester) will be repeated with an alternate form, counting the higher of the two grades; (3) holding a lengthy, comprehensive review session for the final examination in which the information fed to students is as close to examination content as feasible and which is perceived by students as the limited set of content topics and behavior which will actually be included on the examination.

Criterion – Referenced

Interpretation of test results from mastery tests differs in kind from interpretation of "traditional" tests showing a normal curve distribution of total scores. Interpretation here is *relative,* that is in relation to peers. Recently, the term "norm-referenced" has been applied to this kind of test. Under mastery theory a test score in a sense may be considered *absolute,* since one need not compare a score with a peer. One only judges whether a sufficient number of items have been passed to give evidence of mastery of some limited segment of an entire score. In contrast to "norm-referenced tests," the term "criterion-referenced tests" has been applied to those used in mastery learning. With criterion-referencing a new operation is brought into the picture, one which may have far reaching social implications. This will be the interpretation of a test score in terms of describing the specific behaviors which a student can now perform. Thus, it will be much easier to match such a repertory of skills to a forthcoming job or training situation than before when we only knew how a student ranked with his peers but not what he could do.

Frequent quizzes may be used effectively to identify aspects of a course where revision is desirable and to improve the course while it still is fluid. This is an example of the trend toward adapting the course to the student rather than adapting the student to the course.

It should be recognized that while mastery learning theory promises much in educational improvement, very little definite research has yet been done. Therefore, we know little, as yet, about its applicability in education. Meanwhile, it appears worth trying on the part of individual teachers as more persons recognize the weaknesses of traditional instructional and testing practices and try to improve them in accordance with newer methods.

SOME SUGGESTIONS

Teachers are invited to put into practice the theory briefly described in this paper. Each teacher's situation is unique, and there is no guarantee that the same innovation will work everywhere. Run a short-term study of an actual innovation and observe its effect upon teachers, pupils and administrators. Several suggested innovations are:

1. *Give alternate forms of a quiz or examination until students improve to a predetermined level of mastery.* Since the knowledge and skills represented in the test will already have been judged to be important, missing particular items will pinpoint the kind of remedial instruction necessary to bring a student to the desired level.

2. *Involve students as representatives on a committee along with faculty to review a curriculum and to set objectives.* Perhaps the best candidates for such student representatives would be juniors or seniors in high school to set objectives for the freshman class.

3. *Have a student committee make up a final examination in order to show what mastery is required of all students.* Obviously, to do this would drastically change the security precautions usually taken and the grading system employed. However, this would be "experimental," and perhaps it would be found that more benefits would be obtained than the disadvantages associated with security and grading.

4. *Have a student-faculty committee critically review the grading system.* There has never been a perfect grading system. Even some so-called "new" systems seem unsatisfactory.

5. If your school has a new program in individualized instruction and/or independent study, you may wish to strengthen the evaluation you have planned for it. Your own research director or a consultant from a local university can be invaluable here. Several references can be of help, also. Among these are Gleason (1967), Webb (1966), Bloom (1956), and Krathwohl (1968).

6. Run a full-fledged experiment in mastery learning and teaching with the help of a nearby university. Most universities would welcome such an invitation from a local school system. Many of them have graduate students who are looking for an agency in which they may spend time on an internship or on a course project or thesis.

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